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SPECTRAL MEASUREMENT OF WATERSHED COEFFICIENTS IN THE SOUTHERN GREAT PLAINS

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Greenbelt, Maryland 20771

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TEXAS A&M UNIVERSITY
REMOTE SENSING CENTER
COLLEGE STATION, TEXAS

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SPECTRAL MEASUREMENT OF WATERSHED COEFFICIENTS IN THE SOUTHERN GREAT PLAINS

1.0 BACKGROUND & SUMMARY

1.1 Background

This investigation is directed toward testing and modifying a technique developed in a previous study (contract #5-70251-AG Task #5) where a linear combination of Landsat data was related to watershed runoff coefficients. The relationship was developed and tested in a region of central Oklahoma where extensive rainfall and runoff data were available for research watersheds.

In this study, the technique will be tested in two regions, one in central and east central Texas having more dense vegetation than Oklahoma, and the other in arid regions of Arizona and New Mexico where vegetation is less dense. In each region, twenty watersheds will be selected on a basis of the most adequate records of rainfall and runoff. The technique will be tested in each region by developing a relationship between spectral response and runoff coefficients based on ten watersheds and then testing the prediction capability of the relationship on the remaining watersheds in that region.

It is expected that by testing the technique in regions having more dense and more sparse vegetation on the watershed surfaces, an estimate can be made of the

area where the technique is applicable. At the same time, the influence of the quality of rainfall and runoff data used to calibrate the prediction scheme should indicate whether the technique can be useful to practicing hydrologists.

1.2 Summary

Average spectral reflectance for multispectral scanner (MSS) bands four, five, six and seven were plotted versus Hawkins curve number for the Texas watersheds and the Arizona and New Mexico watersheds. Linear relationships between spectral reflectance and curve number existed for the Arizona and New Mexico watersheds with little or no timber cover. Three such relationships exist probably due to differences in soil color and geologic formations. However, there is considerable data scatter for watersheds with varying amounts of timber cover and these data do not correlate with curve numbers determined for the watersheds. Texas watershed spectral data also does not correlate with calculated curve numbers due to the number of watersheds with varying amounts of timber cover.

Since timber cover appears to cause the data scatter, a technique is being developed to remove the spectral reflectance of timber from the average spectral reflectance of the watershed. A preliminary study indicated that

MSS band five minus MSS band seven is considerably different for timbered areas and non-timbered (open) areas. Once a value or range of values is determined for the different tree species, a general expression can possibly be applied to all the watersheds to remove timber cover effects.

2.0 ACCOMPLISHMENTS AND PROBLEM AREAS

2.1 Accomplishments during the Reporting Period

Average spectral reflectance for multispectral scanner (MSS) bands four, five, six and seven versus Hawkins curve number (CN) were plotted for the Texas watersheds and the Arizona and New Mexico watersheds. Texas watershed spectral data are shown in Figures 1-4. No definite correlation between spectral reflectance and calculated curve number is obvious due to the data scatter. The data scatter may be due to a number of factors. The soil surface may not be dry. Landsat scenes were chosen that had low antecedent precipitation index (API) values, however, some of the watersheds have API values of approximately one or greater as reported in a previous progress report. There may also be green vegetation on the watersheds even though the scenes used were during the dormant season. Differences in geologic formations may cause considerable data scatter. Not actually seeing the soil surface due to various amounts of timber cover on the watersheds may also cause the spectral data to be scattered.

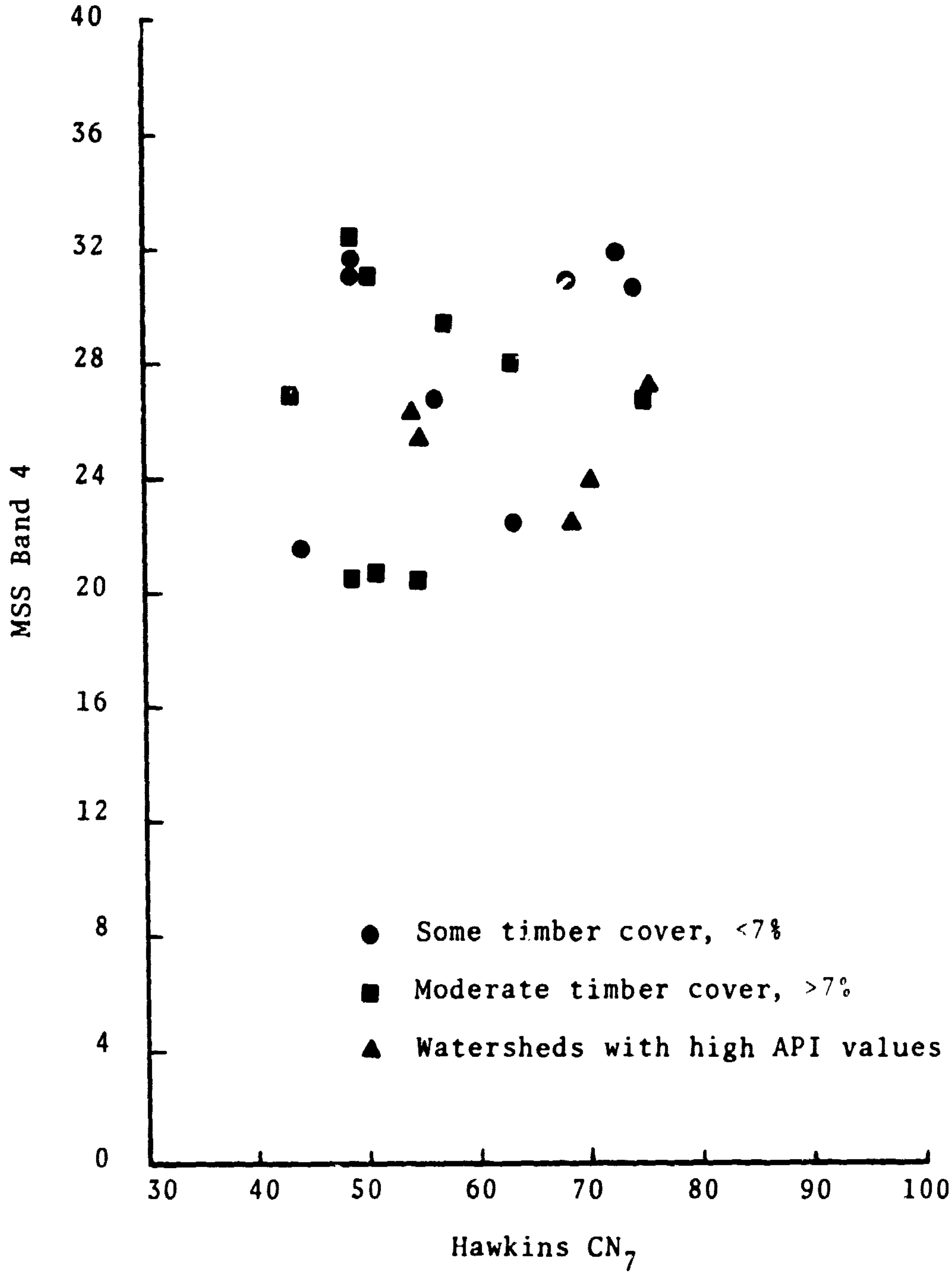

Figure 1. Spectral Reflectance of Texas Watersheds for MSS Band 4 versus Calculated Curve Number.

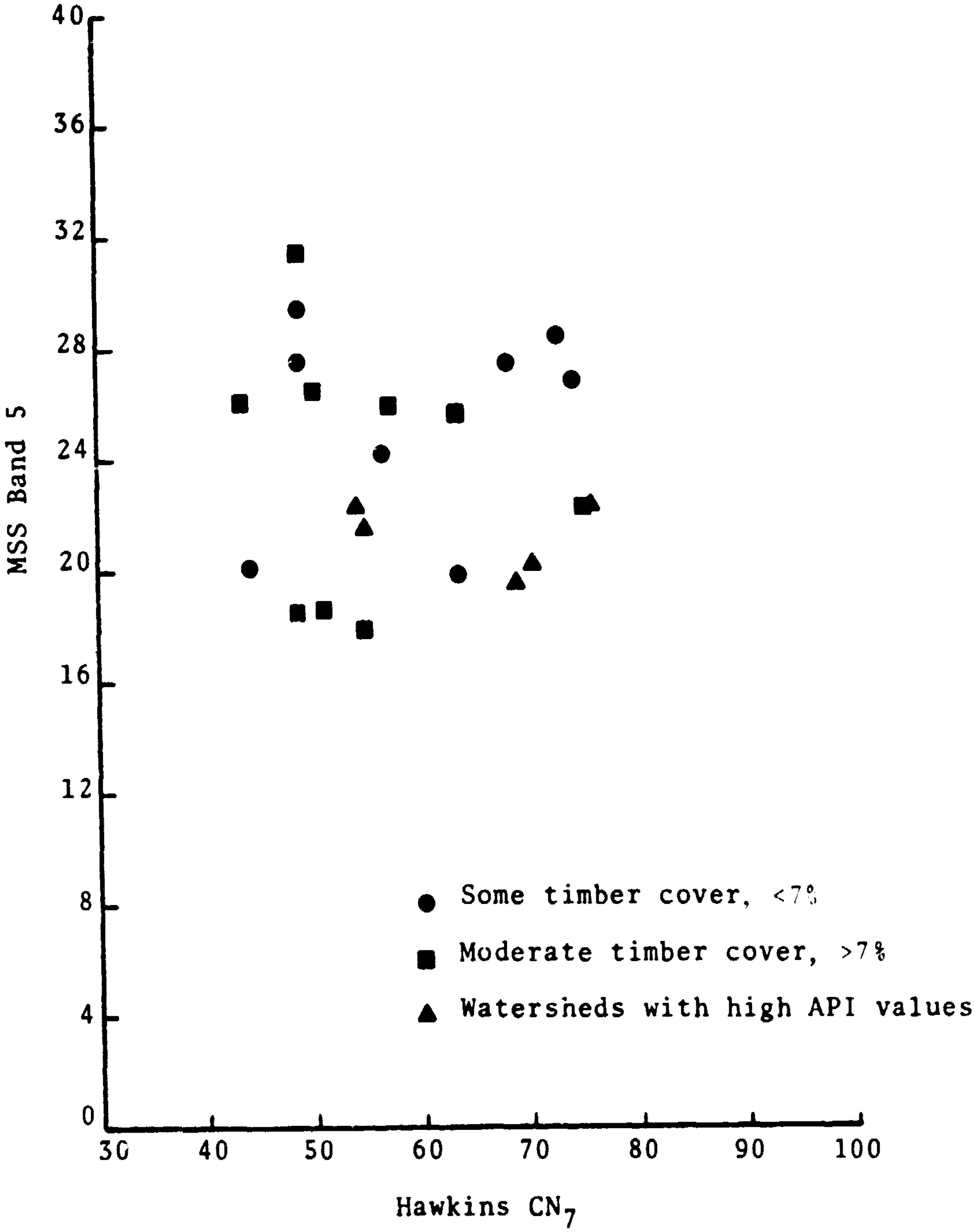

Figure 2. Spectral Reflectance of Texas Watersheds for MSS Band 5 versus Calculated Curve Number

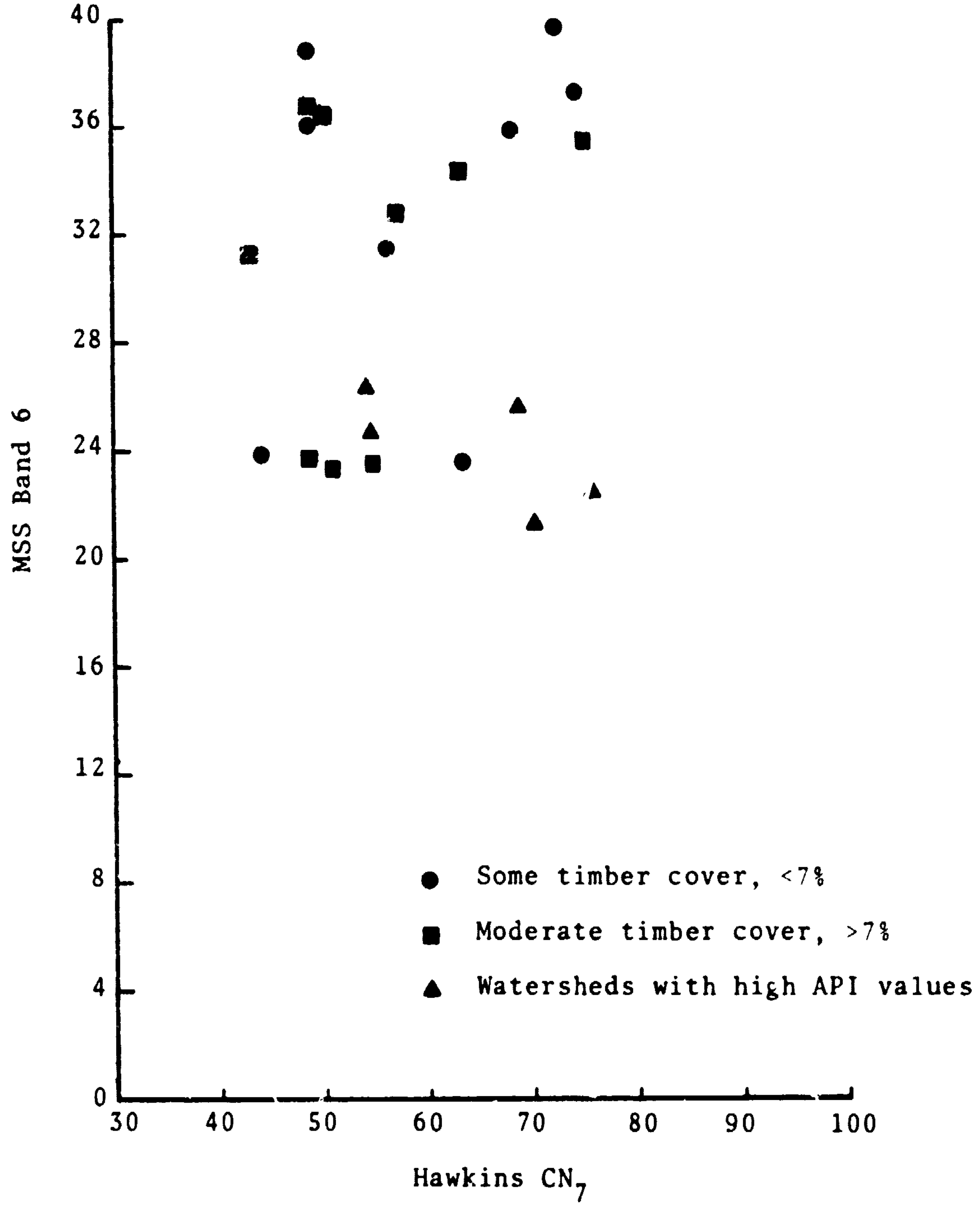

Figure 3. Spectral Reflectance of Texas Watersheds for MSS Band 6 versus Calculated Curve Number

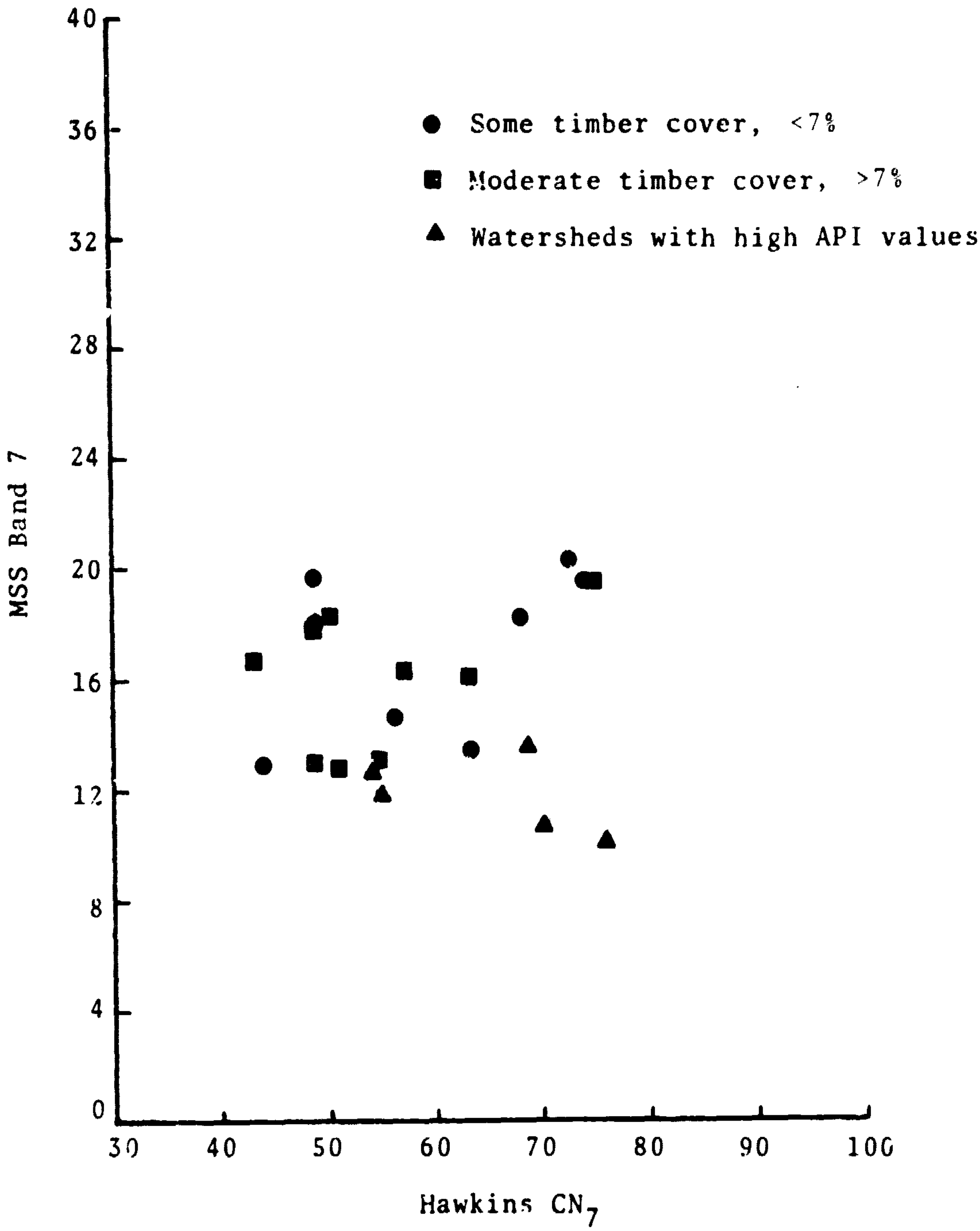

Figure 4. Spectral Reflectance of Texas Watersheds for MSS Band 7 versus Calculated Curve Number

Several combinations of the MSS bands; 5+6-(4+2x7), 5-4, 4+5+6+7, (4+5)/(6+2x7), 5/7, and (5+7)/(5-7); were calculated and plotted versus curve number. None of the above combinations reduced the data scatter or showed any promise of a good correlation between average spectral reflectance for the watershed and curve number.

Spectral data for Arizona and New Mexico watersheds are shown in Figures 5-8. All four MSS bands show a linear relationship between watershed spectral reflectance and CN for watersheds with no timber cover. However, two different relationships are defined. This is possibly due to soil color or some other geologic formation. A third possible linear relationship exists for five other watersheds that have small amounts of timber on them (square symbols). This difference is probably geologic since these watersheds are in a mountainous area.

As with the Texas watersheds, there is considerable scatter in the spectral data. Most of this can probably be explained by differences in geologic formations and various amounts of timber on the watersheds. Antecendent precipitation index values are small (0.05 or less).

Since timber cover on the watersheds is believed to cause considerable data scatter, a preliminary study was conducted to determine what effect trees had on the watershed spectral data. A heavily timbered area in a watershed

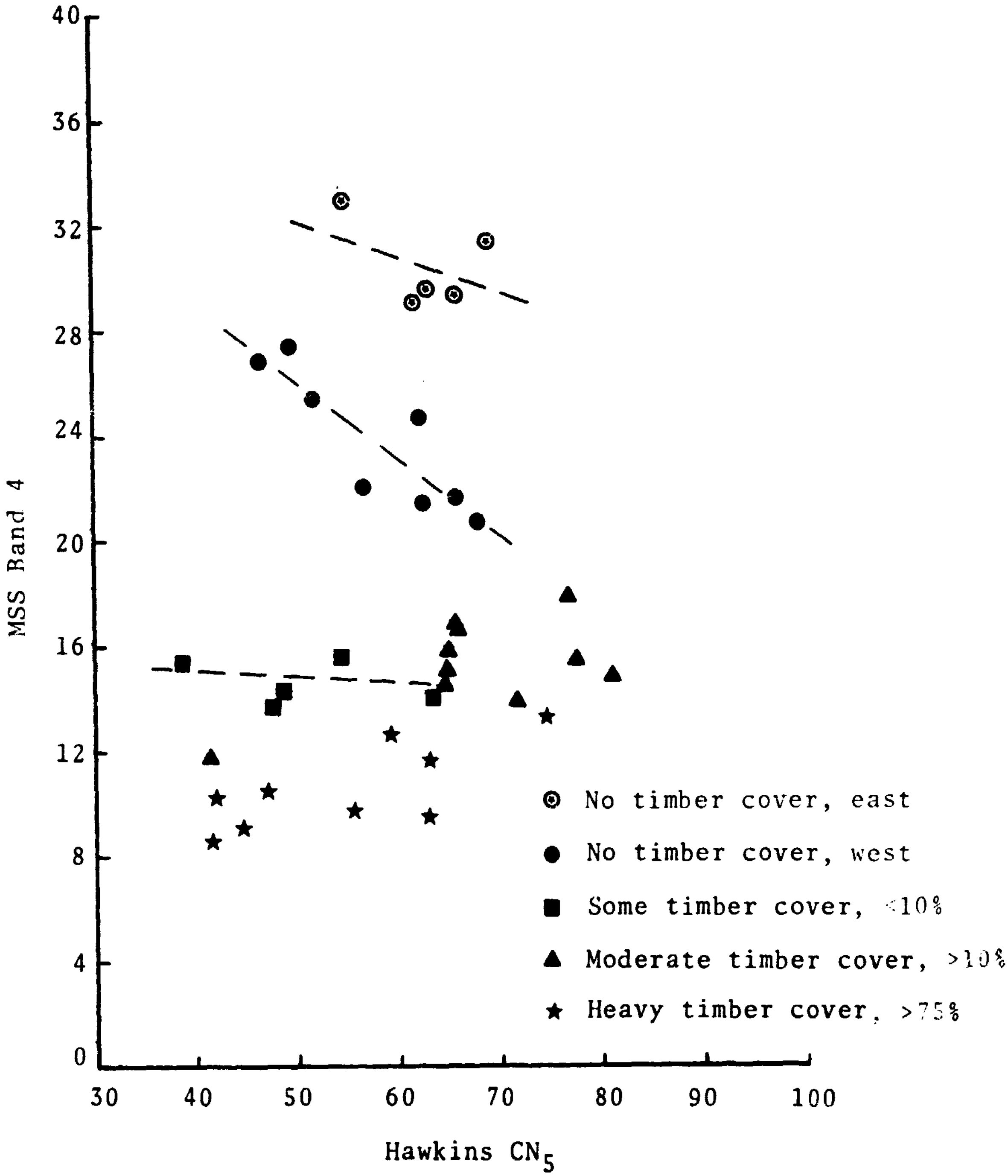

Figure 5. Spectral Reflectance of Arizona and New Mexico Watersheds for MSS Band 4 versus Calculated Curve Number

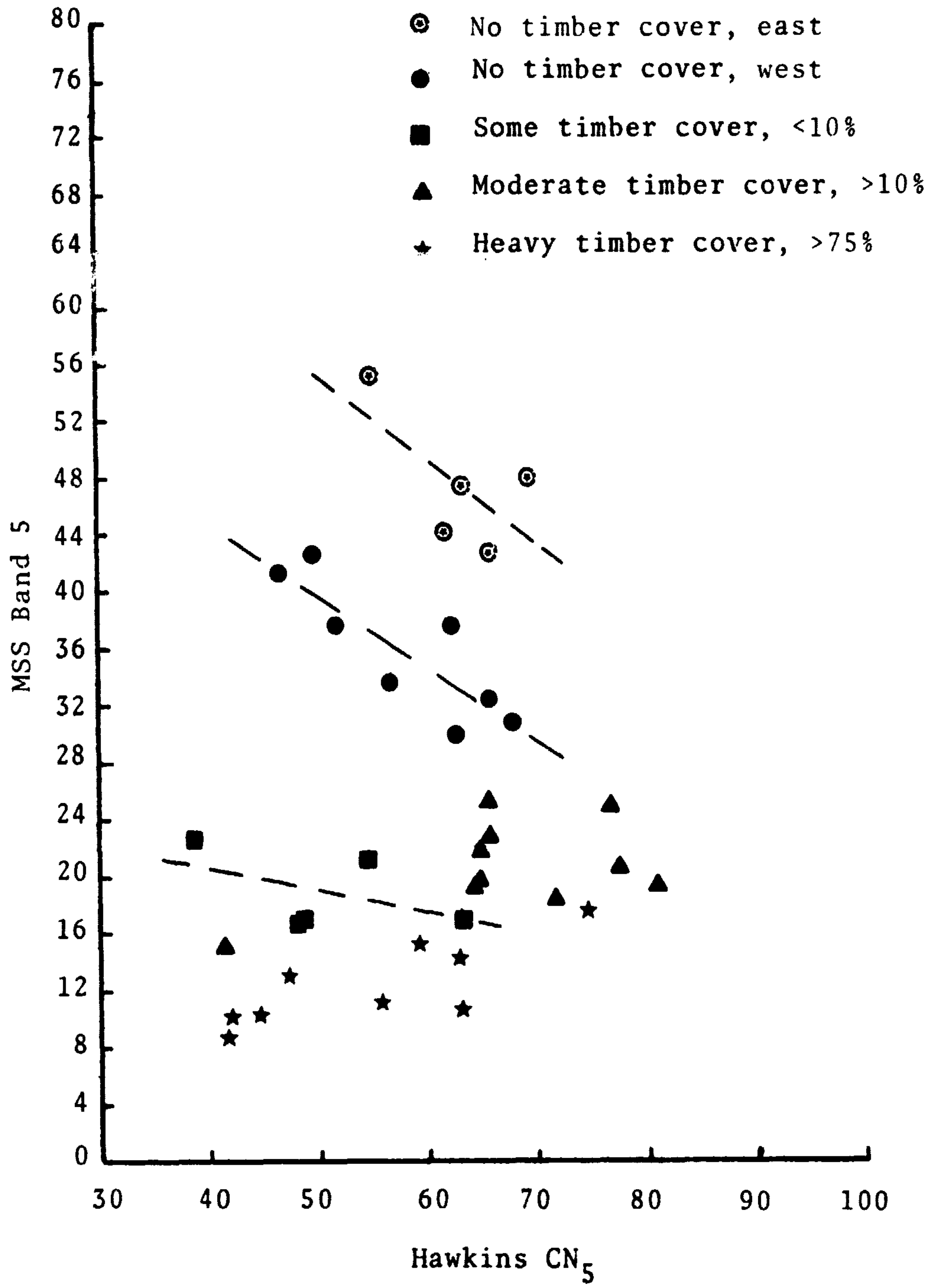

Figure 6. Spectral Reflectance of Arizona and New Mexico Watersheds for MSS Band 5 versus Calculated Curve Number

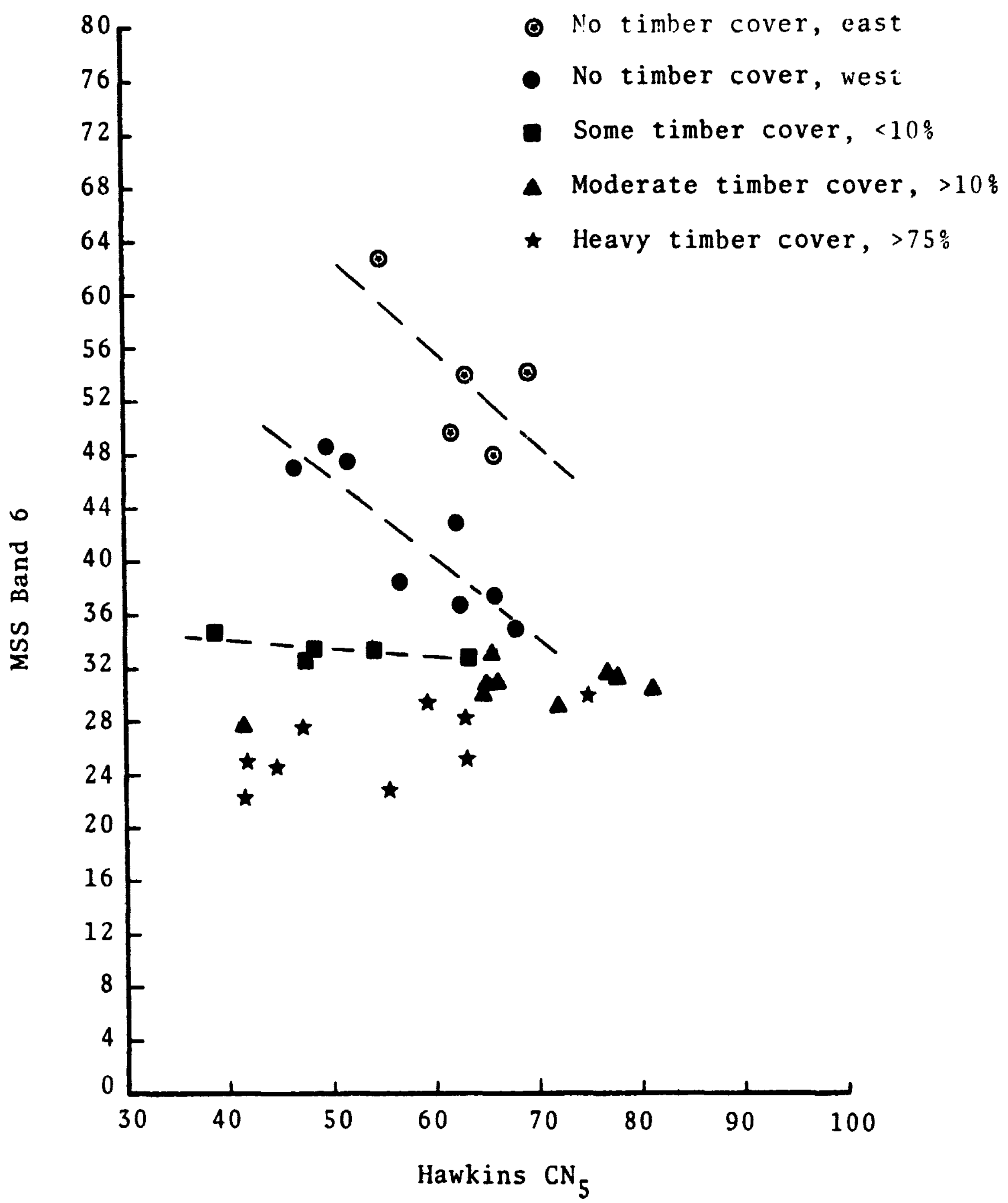

Figure 7. Spectral Reflectance of Arizona and New Mexico watersheds for MSS Band 6 versus Calculated Curve Number

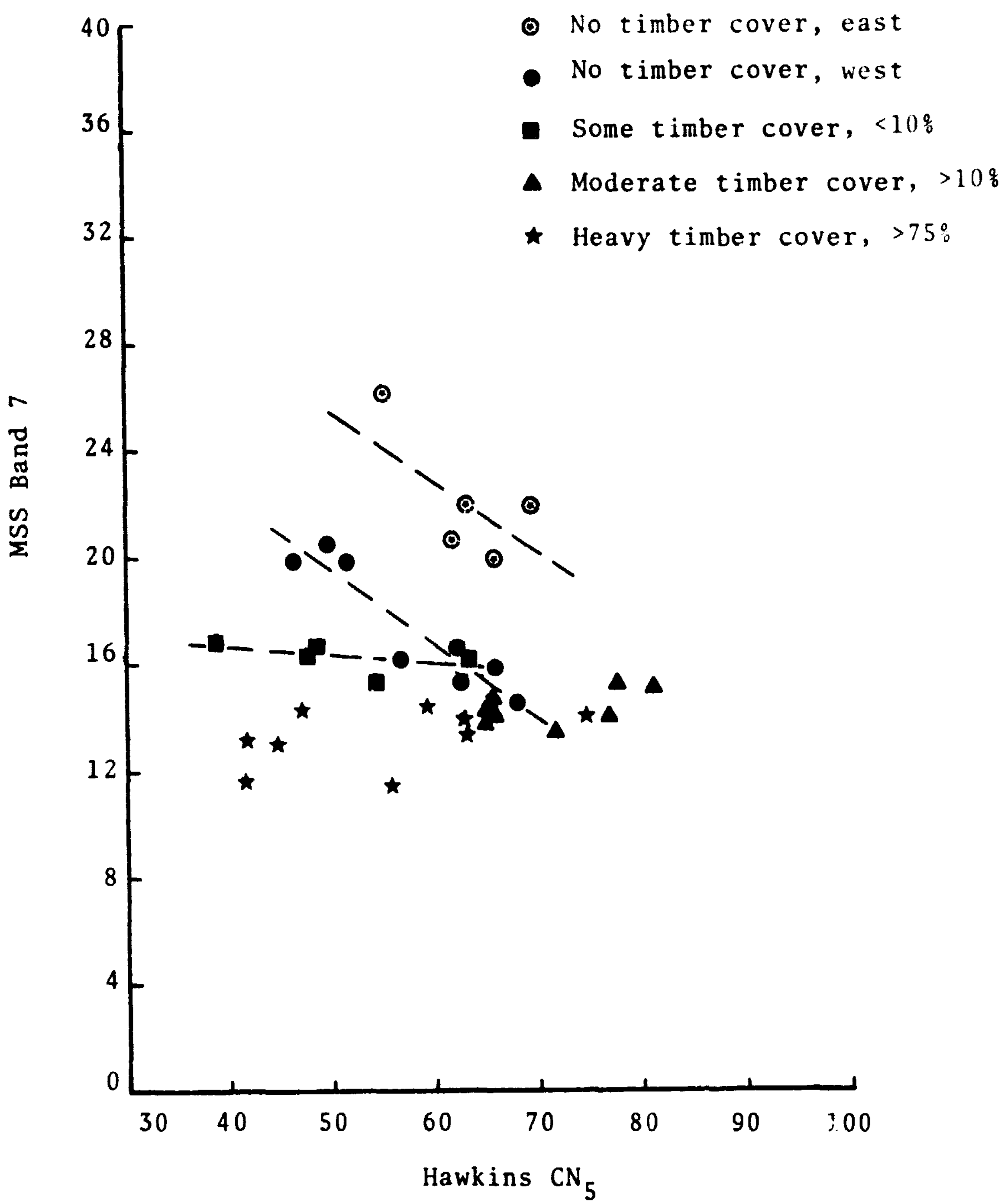

Figure 8. Spectral Reflectance of Arizona and New Mexico watersheds for MSS Band 7 versus Calculated Curve Number

was studied. It was found that the timbered area had a lower spectral reflectance in all four MSS bands than an adjoining non-timbered (open) area. Thus, if the spectral reflectance of the timbered areas in each watershed could be subtracted from the average spectral reflectance for the watershed, the data scatter may be reduced so that a good correlation between spectral reflectance and curve number could be obtained.

To determine the spectral signature of the different species of trees in the watersheds, eight representative watersheds were selected for study, four in Texas and four in Arizona. The digital data within the previously defined watershed boundary were displayed on a dynamic color display (DCD). MSS band five was found to represent the timbered areas best. After being assured that the timbered areas displayed on the screen were similar to the timbered areas denoted by U.S.G.S. topographic quadrangles, small areas representing timber were outlined with a cursor. The mean value of the digital data in the outlined area was computed for the four MSS bands by the computer. Open areas adjoining timbered areas were also outlined and the mean value computed for the four MSS bands. This phase of analysis is not completed, but MSS band five minus MSS band seven for the timbered areas is considerably different from the open areas. After the spectral signature for the different species of trees is determined, hopefully

a general expression can be developed to apply to all the watersheds to remove affects of timber cover on the spectral reflectance of the watershed.

2.2 Problem Areas

None

2.3 Recommendations

None

2.4 Accomplishments Expected During the Next Quarter

Analysis of the eight representative watersheds mentioned earlier will be completed to determine differences in spectral signature for timbered areas and open areas. A general expression will be developed to apply to all the average spectral reflectance of the watersheds. Spectral data for the watersheds will be replotted versus curve number. Hopefully, less data scatter will be encountered so that a good correlation between spectral reflectance and calculated curve number can be obtained.

3.0 SIGNIFICANT RESULTS AND PRESENTATIONS

3.1 Significant Results

None

3.2 Presentations

None